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31 DECEMBER 1979 (FOUO 2/79) 1 OF 1

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31 December 1979

USSR Report

MATERIALS SCIENCE AND METALLURGY

(FOUO 2/79)

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

(FOUO 2/79)

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CONTENTS PAGE

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

CONTENTS (Continued)

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

COATINGS

PROTECTIVE COATING FOR ZIRCONIUM AND ITS ALLOYS

Moscow METALLURG in Russian No 6, Jun 79 back cover

[Article, unsigned: "High-Temperature Protective-Technological Coatings for Zirconium and Its Alloys"]

[Text] The All-Union Institute of Aviation Materials is offering a license for effective technological coatings to protect zirconium and its alloys from oxidation, saturation with gas and alloy burn-off during high-temperature technological heating in rolling, forging and heat treatment.

The good protective properties of the technological coatings result from the presence in them of special components capable of creating a continuous, tough film which insulates surfaces from the oxidizing atmosphere during heating to set temperatures.

The protective-technological coatings ensure stability of the chemical composition of alloy surface layers and permit:
reducing high-temperature scaling 15- to 25-fold;
decreasing the depth of the gas-saturated layer five- to eight-fold (practically no gas-saturated layer);
substantially reducing nonproductive losses of metal, lowering the prime cost of zirconium alloy items;
improving surface quality.

The following protective-technological coatings are used to protect zirconium and its alloys: EVT-29-M, EVT-29-2M for long hold times at 700-850°C; EVT-304 and EVT-207 for hold times of up to five hours at 900-1,000°C.

Protective-technological coating thickness -- 100-150μ, coverage -- 0.2kg/m^2.

The equipment used to manufacture and apply the coatings is similar to equipment used in the ceramics industry. The technological coatings are removed from the surfaces of parts by sandblasting or etching.

The protective-technological coatings are being offered as "know-how."

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COMPOSITE MATERIALS

LIST OF SOVIET ARTICLES DEALING WITH COMPOSITE MATERIALS

Moscow GOSUDARSTVENNYY KOMITET SOVETA MINISTROV SSSR PO NAUKE 1 TEKHNIKE. AKADEMIYA NAUK SSSR. SIGNAL'NAYA INFORMATSIYA. KOMPOZITSIONNYYE MATERIALY in Russian, Vol. 4, No 12, 1979 pp 1-12

[Following is a listing of the Soviet entries from SIGNAL'NAYA INFORMATSIYA. KOMPOZITSIONNYYE MATERIALY [SIGNAL INFORMATION. COMPOSITE MATERIALS], a bibliographic publication of VINITI. This listing is from Volume 4, No 12, 1979.]

[Excerpts]

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2. P. A Device for Producing Bimetallic Parts. Untilov, V. U., Kheyfets, R. G., Rozengart, Yu. I., Ostrenko, V. Ya., Reznikov, Ye. A., Sukonnik, I. M., Chichkov, Yu. V., Oleynik, V. I., Drobich, O. P. (Dnepropetr. metallurg. i-t). USSR Author's Certificate (B23 P3/02) No 626924, Application 11/05/75, No 2133236, Publ. 4/09/78.

3. Viscoelastic properties of a two-phase composite material. Dudukalenko, V. V., Meshkov, S. I. "Fiz. struktury i svoystv tverd. tel (Kuybyshev)," 1977, No 2, 102-105.

4. A Two-Phase Elastic Composite Material of Uniform Strength. Sarayev, L. A. "Fiz. struktury i svoystv tverd. tel (Kuybyshev)," 1977, No 2, 99-101.

5. Experimental Study of the Long-Term Strength of Orthotropic Glass-Reinforced Plastic Oilfield Pipe Under Conditions of Biaxial Tension. Sadykov, R. S., Koltunov, A. A., Nurumbetov, A. N., Matveyev, Yu. M. "Fiz. struktury i svoystv tverd. tel (Kuybyshev)," 1977, No 2, 66-69.

6. P. A Method of Manufacturing Multiayered Shells. Los', A. O., Novikov, V. I., Starikov, N. P., Ivanov, O. M., Sidorkevich, M. A. (In-t elektrosvarki im. Ye. O. Patona). USSR Author's Certificate (B 21 D 51/24, B 21 C 37/12), No 626866, Appl. 18/03/77, No 2463592, Publ. 16/08/78.

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

7. P. A Method of Producing Multilayer Pipes. Osada, Ya. Ye., Kashirskiy, G. A., Bogatov, N. A., Pichurin, I. I., Yaner, V. R. (Volzh. trub. z-d). USSR Author's Certificate (B 21 D 51/24), No 632446, Appl. 7/07/77, No 2505226, Publ. 17/11/78.

8. DEP. Some Properties of the Preparation of Cermets Using TiC_x Phases Prepared by the SVS Method. Tabatadze, G. S., Kozlovskiy, L. V., Ordan'yan, S. S. Leningr. tekhnol. in-t, Leningrad, 1978, 7 pp, ill., bibliogr. 4 items (manuscript dep. at Tsvetmetinform. No 499. Dep. 14 Mat 1979.

9. Hot Pressing and Fusion of Carbide-Carbon Materials. Beketov, A. R., Shabalin, I. L., Fedorenko, O. V. "Tsvet. met.," 1979, No 3, 39-42.

10. Electrodeposition of Polycomposite Coatings. Sayfullin, R. S., Pribysh, I. Z., Borzyak, A. G., Bakakin, G. N. "Iz. vuzov. Khimiya i khim, tekhnol.," 1979, No 2, No 2, 197-199.

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12. Dependence of the Physical and Mechanical Properties of Polyurethanes on the Extent of Filling with Titanium Dioxide. Golovko, L. I., Smetankina, N. P., Misyuk, K. G., Drozhzhin, M. N. "Kompozitsion. polimer. materialy (Kiev)," 1979, No 1, 29-33.

13. The Effect of the Structure of Polyurethane on the Water Resistance of Glued Composites. Kuporev, B. A., Kuksin, A. N., Veselovskiy, R. A. "Kompozitsion. polimer. materialy (Kiev)," 1979, No 1, 24-29.

14. Requirements for Two-Layer Corrosion-Resistant Steel for the Manufacture of Chemical Equipment for Operation in High-Temperature Hydrogen-Containing Media. Arsen'yev, V. I., Chernykh, N. P., Sosnovskaya, T. I. "Sb. nauch. tr. Vses. n.-i. i konstrukt. in-t khim. mashinostr.," 1978, No 81, 70-75.

15. Determining Certain Elastic Characteristics of Unidirectional Composite Materials. Kuz'menko, B. P., Sapozhnikov, S. B. "Sb. nauch. tr. Chelyabinsk. politekh. in-t," 1977, No 201, 74-79.

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Moscow GOSUDARSTVENNYY KOMITET SOVETA MINISTROV SSSR PO NAUKE I TEKHNIKE. AKADEMIYA NAUK SSSR. SIGNAL'NAYA INFORMATSIYA. KOMPOZITSIONNYYE MATERIALY, Vol 4, No 14, 1979 pp 3-4

[Following is a listing of the Soviet entries from SIGNAL'NAYA INFORMATSIYA. KOMPOZITSIONNYYE MATERIALY (SIGNAL INFORMATION, COMPOSITE MATERIALS), a bibliographic publication of VINITI. This listing is from Vol 4, No 14, 1979]

[Excerpts]

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2. Investigation of the transfer of fibrous tungsten and molybdenum from the brittle to the plastic state. Karpinos, D. M., Rutkovskiy, A. Ye., Kondrat'yev, Yu. V. "Poroshk. metallurgiya," 1979, No 3, 44-47. (Eng. abst.)

3. Fabrication of the metal-and-glass assemblies of sealed relays in experimental test production. Yegorov, V. A. "Elektrotekhn. prom-st'. Tekhnol. elektrotekhn. pr-va," 1979, No 4, 4-6.

4. Features of sealing glass with metal contacts. Tikhomirova, O. I., Lopatin, V. A. "Adgeziya rasplavov i payka materialov (Kiev)," 1978, No 3, 102-103.

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8. The strengthening and combination sequence for bimetallic specimens. Okley, L. N., Chkhartishvili, I. V., Zarku, R. Sh. "Protsessy prokatki (Tbilisi)," 1979, no 4, 5-9.

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10. The stressed state of the adhesive bond between a cylindrical fiberglass casing and its top. Ganov, E. V., Dogadin, A. V. "Mekh. kompozitn. materialov," 1979, No 2, 362-364.

11. K. Very hard polycrystalline materials. Tr. VNII abrazivov i shlifovaniya. L., 1978, 94 pp, illustrations, 80 k.

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FERROUS METALLURGY

METAL (IRON) BALANCE IN THE NATIONAL ECONOMY

Moscow VOPROSY EKONOMIKI in Russian No 10, Oct 79 pp 26-34

[Article by L. Zusman]

[Text] The metal balance[1] in the national economy describes the level of metal availability relative to iron content in mined ore arriving for processing. The balance method also enables us to reveal absolute and relative amounts of nonrecoverable losses of metal (iron) at all steps of its cycle of circulation in the national economy, which is of important significance to developing and introducing steps to reduce metal losses.

As is evident from the Table [page following], given an iron content of 36.5 and 99.2 million tons, respectively, in raw and other materials used, the iron content in the metal end product was 23.2 and 69.1 million tons, respectively, that is, 63.6 and 70.5 percent. At the same time, nonrecoverable iron losses decreased from 32.0 to 29.7 percent.

If the level of iron use is determined relative to its content in mined ores, one should add to the indicated nonrecoverable losses those generated in the ore enrichment process. In 1958, some 58.6 million tons of ore with an average iron content of 38.3 percent arrived for enrichment; in 1975, the figures were 358.6 million tons and 32.5 percent. The iron ore concentrate obtained after enrichment contained 54.6 percent iron in 1958 and 62.5 percent in 1975. Thus, the average iron content in iron ore concentrate increased from 16.3 percent in 1958 to 30.0 percent in 1975. The use of enriched iron ore raw material instead of unprocessed ore in blast furnace production enabled us to save approximately 3.0 million tons of coke in 1958 and 15.0 million tons in 1975. However, in this regard, iron losses were 5.5 million tons in 1958 and 22.5 million tons in 1975.

The nonrecoverable iron losses in the national economy were 17.2 million tons in 1958 and 51.8 million tons in 1975. The iron end-use levels

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1. In view of the fact that metal contains an average of about 1.5 percent impurities, raw material is recorded based on its iron content in the overall national economic balance and based on its metal content in semi-finished products and items.

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Table 1. Metal Balances in the USSR National Economy

	1958 г.		1975 г.	
	(1) млн. т	(2) % к итогу	(1) млн. т	(2) % к итогу
(3) Потреблено				
(4) Руды железной товарной	34,3	93,9	98,9	99,7
(5) Серного колчедана	1,3	3,6	—	—
(6) Руды марганцевой и других первичных материалов	0,9	2,5	0,3	0,3
(7) Всего	36,5	100,0	99,2	100,0
(8) Получено				
(9) Для металлоинвестиций в народное хозяйство	23,2	63,6	69,1	70,5
(10) Для экспорта за вычетом импорта металла и металлоизделий	—	—	0,5	0,5
(11) Для импорта за вычетом экспорта металлов и металлоизделий	0,4	1,1	—	—
(12) Для увеличения запасов полуфабрикатов, незавершенного производства	1,2	3,3	0,3	0,3
(13) Для возмещения безвозвратных потерь металла в народном хозяйстве	11,7	32,0	29,3	29,7
(7) Всего	36,5	100,0	99,2	100,0

Key:
1. Million tons
2. Percent of total
3. Consumed
4. Technical-grade iron ore
5. Iron pyrites
6. Manganese ores and other primary materials
7. Total
8. Obtained
9. For metal investments in the national economy
10. For export, less imports of metal and metal items
11. For import, less exports of metal and metal items
12. To increase stocks of semi-finished products and unfinished production
13. To recompense nonrecoverable losses of metal in the national economy

in percentages of that contained in mined ore were 50.2 percent in 1958 and 52.2 percent in 1975. Consequently, only about half the metal contained in the iron ore raw material used increases the amount of metal available to the national economy (see Table 2 [page following]).

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Table 2. Structure of Nonrecoverable Iron Losses in the USSR National Economy

(1) Производство и процессы	1937 г.		1958 г.		1975 г.	
	(2) млн. т	(3) % к итогу	(2) млн. т	(3) % к итогу	(2) млн. т	(3) % к итогу
(4) Обогащение руд	0,2	4,3	5,5	32,0	22,5	43,4
(5) Металлургическое и литейное производство						
(6) вынос рудной пыли из доменных печей	0,9	19,0	0,6	3,5	1,5	2,9
(7) угар железа в процессе плавки	0,2	4,3	0,5	2,8	1,0	1,9
(8) потери со шлаком и мелкими отходами	1,6	34,1	4,0	23,4	7,1	13,8
(9) Металлообработка						
(10) потери в процессах нагрева, травления и шлифовки металлоизделий	0,1	2,1	0,2	1,2	0,7	1,4
(11) потери из-за окисления стальной стружки и неполного сбора металлоотходов	0,5	10,6	0,9	5,2	2,6	5,0
(12) Функционирование металлического фонда						
(13) потери от истирания и коррозии металла	0,7	15,0	3,0	17,1	9,4	18,1
(14) потери от неполного сбора и извлечения металла, закончившего службу	0,4	8,5	2,2	12,5	6,0	11,6
(15) Подготовка металлолома к переплаву						
(16) потери при транспортировке и в процессе резки лома	0,1	2,1	0,4	2,3	1,0	1,9
(17) Всего	4,7	100,0	17,2	100,0	51,8	100,0
В том числе:						
(18) без потерь железной руды	3,5		10,9		26,3	

Key:
1. Production and processes
2. Million tons
3. Percent of total
4. Ore enrichment
5. Metallurgical and foundry production
6. Ore dust loss in blast furnaces
7. Iron loss by oxidation in smelting
8. Losses with slag and small scrap
9. Metalworking
10. Losses in heating, etching and polishing
11. Losses due to oxidation of steel shavings and incomplete scrap pick-up
12. Metal stocks
13. Losses from abrasion and corrosion
14. Losses from incomplete collection and recovery of metal no longer in use
15. Preparing scrap for remelting
16. Losses in transport and cutting scrap
17. Total
18. Excluding iron ore losses

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As is evident from the Table, the proportion of nonrecoverable iron losses generated when ore raw material is enriched increased from 4.3 percent in 1937 to 43.4 percent in 1975. This is to be explained first of all by the fact that the average iron content in the ores being mined has dropped continuously, from 54 percent in 1940 to 35 percent in 1975.

The basic reasons for nonrecoverable iron losses are the following: imperfection of enriching equipment and enrichment technological processes, failure to record the cost of iron losses when choosing an optimum enrichment depth (enrichment dross), unsatisfactory preparation of iron ore raw material (loss of iron ore dust from blast furnaces); inadequate preparation of lightweight scrap metal for remelting and using crushed or twisted shavings without first shaping them into fagots or briquets (oxidation of the iron during the smelting process), inefficient methods of separating metal from slag when tapping a melt or magnetically removing metal particles from production garbage, failure to promptly fagot and briquet shavings (losses of iron due to oxidation of steel shavings).

Losses of metal from wear on the cutting elements of machinery and equipment are also significant. This is associated with imprecise working of parts surfaces, with irregular lubrication and unsatisfactory lubricant quality. As concerns losses of metal from corrosion, this is to be explained by inadequate production of corrosion-resistant (stainless) steels, low-alloy high-strength steels, and rolled metal with corresponding metal coatings (galvanized and tinplated sheet steel) or with nonmetallic protective coatings (plastic, lacquer, and so on).

Not all the metal withdrawn from use can be recovered and used again: metal contained in reinforced concrete structures, steel pipe casings in oil and gas wells no longer being operated, and so forth. The replacement of parts and structures during the course of routine equipment maintenance and major overhaul under field conditions, in geological surveying, at agricultural repair centers and at small industrial enterprises, also leads to nonrecoverable losses.

Analysis shows that losses of iron can be eliminated or reduced as a result of raising the level of iron use when preparing iron ore raw material, by improving techniques, technology and organization in all links of metallurgical, metalworking and machine-building production, by up-dating obsolete technological equipment, by improving the quality of ferrous metals, by increasing the proportion of steel with better abrasion and corrosion-resistant properties, and by improving methods of recovering and collecting scrap metal and metal beyond its service life.

In a number of instances, reducing nonrecoverable losses of metal requires no special expenditures (organizational measures). In others, reducing nonrecoverable losses is associated with considerable capital investments: replacing production equipment and additional operating expenses, changing the technological flow and correspondingly replacing equipment for ore enrichment, improving metal quality, and others. In this regard, a reduction in

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nonrecoverable losses of metal at each particular stage of technique development has an economic optimum, determined in the final analysis as the aggregate savings in expenditures of social labor in the national economy as a whole.

Most significant is the economic loss from metal wear and corrosion, which is expressed not so much in the amount of physical losses of metal as in the premature unsuitability of the parts and structures of machinery and equipment for continued use and their being forced to shut down for repairs and to replace parts. Annual expenditures on major overhauls and routine maintenance are 45-50 billion rubles (with metal wear and corrosion accounting for 25-30 billion rubles), not counting losses from fixed production asset down-time during repairs.

In our country, steps are being taken systematically to reduce economic loss from metal corrosion. Over the past 10 years, the production of stronger low-alloy steel has been increased, the production of stainless and sheet steel with corrosion-resistant coatings has been expanded, and the quality of various types of paints and varnishes used as coatings has been improved. The Corrosion Institute, attached to the GKNT [not further identified] was created in 1978 to study more thoroughly means to combat metal corrosion and to coordinate interdepartmental activity in this field.

It is calculated that nonrecoverable metal losses in enrichment processes will be approximately 130 million tons, equivalent to nearly 400 million tons of unprocessed iron ore, in the 10th Five-Year Plan. These enormous losses of raw material are essentially not being evaluated, since only 15 kopecks is included in the prime cost per ton of ore at present for recompensing expenditures on geological prospecting work. At the same time, losses arising in the iron ore enrichment process must be compensated for by operating additional mines where higher proportionate capital investments and current operating expenses are required than for mines with similar indicators in a given ore-mining region, that is, closed expenditures, due to mining-geological conditions and physical distribution.

Remelting the metal scrap generated at all stages of production and processing also influences the metal balance, since the usable metal output obtained from this scrap is again returned to metal consumption (see Table 3 [page following]).

The data testify that, as a result of remelting metal scrap, the iron use factor increases from 0.586 to 0.899. However, in the remelting process the nonrecoverable losses factor increases from 0.073 to 0.101.

Total nonrecoverable losses relative to metal initially received in the consumption process consists of three components: nonrecoverable losses in remelting metal initially received in metallurgical production; nonrecoverable losses in regenerating scrap from consumption of metal initially received; nonrecoverable losses in the process of consuming regenerated metal.

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

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Table 3. Distribution of Metal in its Production and Consumption in 1975

	(1) Металлургическое производство	(2) Металлообработка, машиностроение и строительство	(3) Производство и потребление металла
(4) **До переплава металлоотходов**			
(5) Коэффициент:			
(6) использования железа	0,722	0,812	0,586
(7) оставшегося железа в отходах	0,221	0,162	0,358
(8) безвозвратных потерь железа	0,057	0,026	0,056
(9) Итого	1,000	1,000	1,000
(10) **После переплава металлоотходов**			
(5) Коэффициент:			
(6) использования железа	0,927	0,970	0,899
(8) безвозвратных потерь железа	0,073	0,030	0,101
(9) Итого	1,000	1,000	1,000

Key:
1. Metallurgical production
2. Metalworking, machine building and construction
3. Production and consumption of metal
4. Prior to remelting scrap metal
5. Factor:
6. Iron use
7. Iron remaining in scrap
8. Nonrecoverable iron losses
9. Total
10. After remelting scrap metal

We shall designate the relative amount of nonrecoverable metal losses for 1975 during the production process (0.057) as a_0, losses in the consumption process (0.026) as $в_0$, the relative amount of scrap metal used as a_1 (0.221) and $в_1$ (0.162), respectively, and the metal use factor in the consumption stage as a (0.812). Then the total nonrecoverable metal losses in the consumption process will consist of the following components:

(1) Обороты	(2) Количество металла, поступившего в данный оборот (в т)	(3) Безвозвратные потери металла в обороте (в т)
(4) Первый	1,0	$в_0 = 0{,}026$
(5) Второй	$в^1_1\ \Sigma a = 0{,}162 \times 0{,}812 = 0{,}131$	$в^1_0 = 0{,}131 \times 0{,}026 = 0{,}0034$
(6) Третий	$в^2_1\ \Sigma a^2 = 0{,}028 \times 0{,}812 = 0{,}023$	$в^2_0 = 0{,}023 \times 0{,}026 = 0{,}0003$

[Key on page following]

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

Key:

1. Cycle
2. Amount of metal received in the cycle, in tons
3. Nonrecoverable losses of metal in circulation, in tons
4. First
5. Second
6. Third

It is evident from the calculation of metal losses in metal-consuming branches as a result of the recycling of metal scrap and usable metal obtained between metal-consuming and metallurgical production that when metal recirculation cycles are repeated, the relative amount of metal decreases consistently. And the amount of nonrecoverable metal losses decreases correspondingly, approaching zero with an unlimited number of cycles.

Remelting scrap metal, repeated rerolling of ingots and blanks obtained from this scrap, and repeated processing of metal obtained as a result of remelting metal scrap require considerable capital investment and current expenditures in all cycles of metallurgical and metalworking production.

Given a found value θ_0, θ_1 and Σa, total nonrecoverable losses $\Sigma\theta_0$ from reprocessing metal recovered from scrap will seek a certain limit, which can be calculated using the formula $\Sigma\theta_0 = \theta_0 : (1-\theta_1\Sigma a) = 0.026; (1.0-0.162 \times 0.812) = 0.30$ tons.

Consequently, an additional 0.004 tons (0.030 - 0.026) of nonrecoverable metal losses is generated as a result of reprocessing one ton of regenerated metal from scrap obtained in the metal-consumption process.

Moreover, additional nonrecoverable losses of metal arise in metallurgical production in the process of remelting and repeatedly rerolling metal contained in scrap received from metal-consuming branches. As calculations have shown, these losses average 11 tons. Thus, the total amount of nonrecoverable losses per ton of incoming metal is 0.041 tons in the consumption process.

The relative amount of scrap metal in metalworking which is sent to metallurgical production for regeneration as a result of repeated scrap metal recirculation cycles will, given the given coefficients of iron distribution in metallurgical and metal-consuming production, seek a certain constant value, which can be determined using the following formula:

$$\Sigma\theta_1 = \theta_1 : (1 - \theta_1 \Sigma a).$$

By substituting 1975 data in this formula, we find that the amount of scrap metal equals 0.186 tons (0.162 : (1-0.162 x 0.812)), that is, the amount of scrap metal increases by 0.024 tons relative to metal consumed. We should also add to this amount the scrap metal generated in metallurgical production in the process of remelting metal-consuming production scrap: 0.041 tons (0.186 x 0.221), where 0.221 tons is the amount of scrap metal obtained in metallurgical production per ton of primary metallurgical raw material being consumed.

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

Thus, 0.227 tons (0.186 + 0.041) of scrap is obtained per ton of metal received in metal-consumption as a result of the circulation of scrap metal between metal-consuming and metallurgical production.

Of the total amount of scrap metal to manufacture consumer goods in 1977, 1,956,000 tons was used in ferrous metallurgy, 345,000 tons was used to manufacture production items, 2,189,000 tons was exported, and the remaining 56,293,000 tons was used as secondary metal raw material for remelting in steel smelting and cast iron production.

The scrap metal actually generated exceeds the amount of metal raw material collected for remelting. The uncollected portion of the metal scrap is primarily in the form of iron and steel shavings (8,187,000 tons in 1977). If it is assumed that the collected metal scrap in foundry production, metalworking and construction is 95 percent and shavings are 85 percent, then nonrecoverable losses of metal scrap are 2.5 million tons, and the steel and iron shavings generated in metalworking in 1977 were 9.6 million tons.

A significant portion of the steel shavings oxidize because they are not pressed into fagots and briquets promptly. Metal losses due to this are approximately 5-10 percent relative to the steel shavings collected, that is, 400,000 to 800,000 tons. Much metal scrap from foundry production is mixed with the sand, hauled to the slag dump, and the metal only partially recovered. A substantial portion of the scrap metal is lost at construction sites. Overall losses of metal scrap are nearly 2.5 to 3.0 million tons, so retaining this scrap is an important reserve for increasing raw material resources for metallurgical production.

Collecting scrap metal and preparing it for remelting and for transport to procurement sites and scrap processing plants of the "Soyuzvtorchermet" system and then to metallurgical plants requires 600-800 million rubles per year in current expenses. Were metallurgical production (including foundry production) not linked to production outlays, things would be different in forging, stamping, and especially in cutting medal.

Calculations show that expenses on removing one ton of shavings approximately equal the average cost of the finished rolled metal. Consequently, when about 9.6 million tons of iron and steel shavings were obtained in metal-cutting production in 1977, production outlays on removing it using the machine tools were 8-9 billion rubles, and the value of the lathes and plant services used to remove it exceeded three billion rubles. More than 1.0 billion rubles in current expenses was required to remelt 56.3 million tons of metal scrap, and the capital investments made in this connection were 2.0 to 2.5 billion rubles. The data presented show the potential economic impact, given a relative reduction in the amount of metal scrap.

Circulating metallurgical production scrap decreased relative to marketable metal output from 26.8 percent in 1958 to 20.0 percent in 1977. As a result of the reduction in metal scrap in 1977 as compared with 1958, an additional roughly five million tons of metal output was obtained, with simultaneous

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

improvement in quality and assortment. At the same time, the relative reduction in circulating metal scrap has been retarded in recent years in connection with the increased amount of metal output being subjected to additional IV conversion processing. Continuous steel teeming is being introduced slowly.

Based on a correlation of reporting data from 5,200 metalworking and machine-building enterprises and from enterprises of other branches with metalworking production, the VNIPIlom [All-Union Scientific Research and Planning Institute of Scrap] estimates that the weighted mean amount of scrap in metalworking (including forging and stamping) remained practically unchanged from 1965 through 1977 (see Table 4).

Table 4. Amount of Scrap Metal Collected

(1) Наименование производств	(2) В 1977 г. тыс. т	(3) На 1 т продукции (в кг)			
		1965 г.	1970 г.	1975 г.	1977 г.
(4) Доменное	446	8	5	4	4
(5) Сталеплавильное	4 759	34	34	33	32
(6) Прокатное	24 912	278	258	247	244
(7) Трубопрокатное	1 188	102	89	83	78
(8) Метизное	463	66	62	58	58
(9) Производство прочих черных металлов	283	41	38	39	42
(10) Всего в черной металлургии	32 050				
(11) Чугунолитейное	5 884	325	326	323	321
(12) Сталелитейное	3 098	514	521	518	524
(13) Всего в литейном производстве	8 982				
(14) Металлообработка и машиностроение	18 690	197,3	200,4	198,5	200,2
(15) Строительство	1 062	30	29	29	29
(16) Итого	60 784				

Key:

1. Type of production
2. In 1977, in 1,000 tons
3. Per ton of output, in kg
4. Blast furnace
5. Steel smelting
6. Rolling
7. Pipe rolling
8. Hardware
9. Production of other ferrous metals
10. Total for ferrous metallurgy
11. Cast iron
12. Cast steel
13. Total for foundry production
14. Metalworking and machine building
15. Construction
16. Total

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

Consideration should be given to the fact that the average level of metal use is closely related to the branch structure of metal consumption in machine building and to the intrabranch structure of metal items. Thus, if the average level of the specific amount of metal scrap for heavy machine building in 1977 is taken as 100 percent, the average level of metal scrap in other branches was 151 percent for electrical engineering industry, 143 percent for machine-tool building industry, 121 percent for tool-making, 129 percent for chemical machine building, 127 percent for machine building for light and food industry, 108 percent for construction and road machine building, 141 percent for automotive industry, 106 percent for tractor and agricultural machine building, 154 percent for other branches of machine building, and an average 125 percent for all machine building.

Reserves for raising the level of metal use in metalworking and machine building branches are substantial, but their use is interbranch in nature to a significant extent. The assortment of ferrous metals largely predetermines the specific amount of metal scrap obtained during their consumption. The supplying of metal output based on size and shape and in precise accord with specified orders is of considerable importance.

The technical level of the machine-building procurement base determines the ratio between the consumption of cast, forged and stamped materials and parts worked by cutting. Therefore, partial replacement of iron and steel cast pieces, which increase the specific weight of machinery, with welded sheet pieces requires a corresponding change in the technical structure of machine-building billeting production, as does the partial replacement of section-shaped parts worked by cutting with bent shapes and sheet metal. It is necessary to increase the proportion of stamped and pressed pieces while reducing the proportion of cast and metal-cutting equipment. Unfortunately, the machine-building procurement base is being restructured extremely slowly.

These metal-conserving directions are closely linked and mutually determinant. The additional specific expenditure of metal in its production (for example, in connection with manufacturing bent shapes out of sheet steel or high-precision profiles out of section-shaped steel) enables us to reduce or even eliminate working these shapes in billeting production and to reduce losses of metal correspondingly. Both increasing the precision of machine parts by additional grinding and polishing and reducing friction and wear on these parts during operation of the machines facilitate lowering the metal use coefficient in machine building.

In view of this, metal use indicators cannot be analyzed separately in the production or consumption process. However, the dynamics of the metal use coefficient are presently viewed in isolation in ferrous metallurgy, metalworking and machine building, and conclusions are drawn as to lowering or raising the metal-intensiveness of production on the basis of change in this coefficient. Such conclusions do not reflect the essence of the phenomenon and give an incorrect picture of the problem of metal-intensiveness as a whole. Given the orientation of metallurgical production to achieve a lower level of metal-intensiveness regardless of how that is achieved, we are

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encouraging a reduction in economical rolled metal shapes, and so forth. And this also applies to evaluating the dynamics of metal-intensiveness in machine building and metalworking. As a result, the national economic ultimate impact is reduced significantly.

The wholesale price per ton of finished rolled metal product made of carbon steel averages about 100 rubles, of machinery and equipment -- 1,000 to 1,500 rubles, and of machinery replacement parts and subassemblies -- about 2,500 rubles. If an additional ton of metal scrap is generated in the metal production process, after remelting, the additional expenses to obtain metal suitable for use are 20-25 rubles. In forging and stamping production, additional expenses per ton of metal scrap (including remelting metal scrap and reworking the metal) are approximately 75 rubles, and in metal-cutting production -- about 300-600 rubles (including current expenditures on working the metal); with premature removal and replacement of one ton of parts while the machines are in operation -- at least 2,000 rubles (including all repair expenditures).

Therefore, from the viewpoint of ultimate national economic results, the level of metal-intensiveness of metallurgical production must be determined by the tasks of machine building, just as the level of metal-intensiveness of machine building must be determined by the task of lowering the operating metal-intensiveness of machinery and equipment. But if raising the metal use coefficient is achieved at the expense of lowering the proportion of metal-intensive shapes and types of metal output which have a high impact on metal consumption or increasing the proportion of section-shaped cast items consumed in machine building and which require less working as compared with shaped rolled profiles but which increase machine weight, it is not efficient from the viewpoint of national economic end results.

Positive advances have occurred in the structure of machine-building output in recent years. The proportion of computer equipment, automation devices and apparatus, precision machine tools and units, in machine-building output has been increased. Automated and comprehensively mechanized (entirely or just basic production) enterprises employing 11 percent of all industrial-production personnel provide 19 percent of the industrial output. The production of machinery and equipment for fundamentally new or modernized technological processes has been increased in various branches of machine building. The new methods of working metals are associated to a certain extent with the use of new types of metal which are hard to work but whose use in machinery and apparatus permits a substantial intensification of technological processes and which increases their durability. The precision to which parts can be worked is increasing, as is borne out by the growth in the number of grinding and polishing machines.

Therefore, whereas there is a slight increase in the metal-intensiveness of machine-building production for the reasons presented above, it is fully recompensed by the reduction in operating metal-intensiveness of a number of types of machines, apparatus and devices. In view of this, the change in

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the coefficients of metal use in machine building and metalworking cannot serve as a criterion for evaluation without an analysis of national economic end results.

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FERROUS METALLURGY

IMPROVING THE QUALITY AND STRUCTURE OF METAL PRODUCTION

Moscow VOPROSY EKONOMIKI in Russian No 10, Oct 79 pp 35-43

[Article by N. Ivantsova: "Improving the Quality and Structure of Metal Production"]

[Text] The decisive factors as regards improving the efficiency of utilization of metals and reducing the metal requirement of production are improvements in the quality and variety of rolled stock and in the structure of metal production. That is to say, here the intensive rather than extensive path of development of ferrous metallurgy is meant. But this orientation still does not prevail. The extensive path of development requires considerable outlays by the economy in view of the high capital, material, and labor requirements of ferrous metallurgy. In 1975 ferrous metallurgy accounted for about 6 percent of gross industrial output, about 10 percent of industrial fixed capital, 8 percent of capital investments, 6 percent of material outlays, and 4.1 percent of industrial employment.

The constantly growing demand of the national economy for metals can be satisfied by smaller quantities of ferrous metals provided that their quality is improved and the variety of rolled stock produced is broadened. Then, as shown by an analysis of the structure of metal consumption, with allowance for requirements that must be met by the production and structure of rolled stock, the expenditures could be cut roughly in half: metal waste would be markedly reduced, as would be the metal requirement of production. The existing structure of rolled stock is chiefly due to the insufficient use of sheet metal in machine building, and especially of thin (including cold-rolled) sheets, as well as of certain economical types of production, rolled sections, heat-hardened rolled stock, and coated and low-alloy-steel rolled stock.

Of major importance to improving the qualitative characteristics of metals and the structure of rolled stock are the alloying and microalloying of steel, continuous casting, pressure casting, treatment of steel directly in the furnace, heat treatment of rolled stock and monitoring of rolling processes. Another desirable development would be an increase in the output and proportion of metal plate (particularly sheeting), coated rolled stock, and cold-rolled sheets, as well as a marked expansion of the variety of roll-formed shapes. The demand of the national economy for these types of rolled

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

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stock greatly exceeds their production because the present capacity of ferrous metallurgy is inadequate to satisfy this demand and, owing to a number of technical and economic factors, machine building is not always capable of effectively utilizing quality rolled stock.

The expansion of the output and consumption of quality types of metal as well as improvements in the structure of the metal stock produced laregly depend on the solution of three complex problems in metallurgy and machine building (in the spheres of the production and consumption of metal): raising the technical level of the processes of the production and consumption of metal; optimization of the organizational structure of ferrous metallurgy and of preparatory production in machine building; and improvements in the system for planning and stimulating the production and consumption of economical lightweight types of metal.

The principle factor in improving the quality and broadening the variety of rolled stock in raising the technical level of the branch. In recent years the intensification of metallurgical processes has greatly progressed, which has contributed to elevating that level. Nevertheless, part of the existing facilities still do not satisfy from the technical and economic standpoint the present-day requirements for scientific and technological progress and for the fabrication of highly effective metal products. A considerable quantity of steel-melting (and, particularly, rolling, pipe-casting, and hardware-manufacturing) equipment needs to be updated. Thus, one-fifth of all rolling mills, blast furnaces, and open-hearth furnaces are more than 30 years old. The service life of roughly 40 percent of all furnaces and mills exceeds their officially rated period of depreciation (the effective service life of metallurgical equipment is no longer than 20-25 years). The renovation of fixed capital in metallurgy proceeds more slowly than in other branches of industry. The coefficient of retirement of fixed capital in that branch in 1977 was 0.9 percent compared with the industry-wide average of 1.5 percent. The production cost of metal products manufactured by obsolete equipment exceeds the cost of products manufactured by modern rolling mills to the extent of 10 rubles per ton for iron and steel, 6 rubles per ton for rolled sections, and 2.5 times as much per ton for sheet metal.[1] At the new rolling mills labor productivity is 1.5-2 times as high, capital outlays are about half as high, and the consumption of metal per ton of rolled stock is 3-7 percent lower for hot-rolling section mills and 15-17 percent lower for strip mills.

Ferrour metallurgy still suffers from a shortage of certain types of technological equipment: facilities for in-furnance treatment of metal, continuous steel casting machinery, rolling equipment--particularly regular as well as cold sheet rolling equipment, and facilities for the application of protective coatings to rolled stock and for the heat treatment of metals. All this holds down the production of metals with desired quality characteristics and in the desired structural variety. More than 10 million tons of metal annually is wasted owing to corrosion. A marked

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

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expansion of the output of coated rolled stock is therefore an urgent problem. At the same time, various models of equipment for the application of protective coatings to structural metal components, developed by the Project Design Institute of Metallurgical Machine Building (VNIImetmash [All-Union Scientific Research Institute of Metallurgical Machine Building]) are being developed and introduced sluggishly owing to the absence of appropriate special-purpose facilities for their construction.

The assurance of an adequate quality of metal products requires improvements in the performance characteristics of various types of metallurgical equipment. Despite the great advances made in the field of developing progressive metallurgical equipment, the technical level of certain currently built types of that equipment lags behind that of the leading specimens of world technology, particularly in such parameters as precision of operation, higher quality indicators of metal, unit power, level of automation, and productivity. Thus, the roughing and billet mills built in the USSR in the last 10-15 years surpass their best foreign-made counterparts as regards design, composition of basic equipment, rolling rates, and productivity, but lag behind these counterparts as regards the composition of finishing equipment and, particularly, the level of automation. Improvements in the quality of metal products require appropriate equipment with high technical and performance parameters, but so far this equipment is not being built in adequate quantities. The imports of such equipment are costly and entail problems of its effective utilization, supply of spare parts, proper training of personnel, etc.

Improvements in the quality of metal will be promoted by an accelerated introduction and development of new technological processes and by a further intensification of production. In modern metallurgy the most progressive technology is represented by the [oxygen-] converter and electric melting methods, which assure a higher quality of metal. Priority should be given to developing electric vacuum melting and electroslag, plasma, and other processes which contribute to improving the quality of steel by enhancing the purity and homogeneity of the metal. Service life of products fabricated from the metal thus obtained is 1.5-2.5 times longer. According to the TsNIIchermet [Central Scientific Research Institute of Ferrous Metallurgy], the attendant savings amount to 200 rubles per ton of electroslag-melted steel and 67 rubles per ton of steel melted in vacuum furnaces.

The quality of metal is particularly improved by the continuous steel casting method, which serves to sharply reduce metal waste in melting and rolling operations and to increase the output of acceptable products by 15-20 percent. Continuous casting is of major importance to the development of the technology, organization, and economics of metallurgical production, and it contributes to introducing continuity and intensification of the metallurgical process. Research is under way to develop continuous

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

steel producing processes that would assure compactness, total automation, and cost effectiveness of production as well as a stable and high quality of the steel ingots. A pilot facility for production of steel by the continuous method has been built and now awaits industrial introduction.

A promising trend in ferrous metallurgy is the cokeless method of direct reduction of iron from ore with subsequent remelting of the metallized raw material in electric arc furnances. This will change the metallurgical cycle by eliminating blast furnaces and the burning of coke and hence also reducing capital outlays and shortening the periods of construction of metallurgical plants. Other consequences will be a reduction in the pollution of water and air basins and improvements in the quality of steel. In the USSR at present the first section of the Oskol'skiy Electrometallurgical Combine for the production of steel by the direct iron reduction method has been completed.

Of major importance to producing materials with specified properties is the powder metallurgical method, which makes it possible to obtain materials of high purity and homogeneity as well as complex composite metal-nonmetal materials. and to monitor every stage of the technological process and adjust the properties of materials. The powders can be used to fabricate parts of elementary or highly intricate shapes. The fabrication of parts from powders by the compacting method, particularly of intricately shaped parts, results in substantial economic savings: unit capital requirement is reduced to from one-half to one-third, and each ton of parts made from the powders saves 1.5 million rubles. This is achieved owing to the attendant high productivity, the absence of need for metal-cutting operations, the 30-35 percent reduction in material consumption, and the savings of electric power.

Fairly often, the employment of advanced forms of metal production in machine building is impeded by the nature of the existing production facilities, technological processes, and machine designs. As the quality of rolled stock improves, machine designs and machine building technologies should correspondingly be adapted in a planned and consistent manner within the machine building industry. This concerns improvements in the design and technology of the principal types of machine building, with allowance for a broader utilization of rolled stock instead of castings, rolled sheets instead of roll-formed shapes, and other quality types of metal. A number of the nation's organizations have been working to substantiate the technical and economic aspects of the production of welded structures from rolled stock instead of from castings. Thus, the institutes of the machine tool building industry have drafted designs for replacing cast-iron machine tool beds with their welded counterparts for grinding machines, lathes, and presses. It has been calculated that the weight of the welded beds is about only 65 percent as high as that of the cast-iron beds, and that they are 30-40 percent stronger. The expediency of using sheets instead of casting

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

in the production of a majority of machine tools used for finishing operations as well as in the production of 79 base components at the Voronezh Machine Tool Building Plant has been demonstrated.

The Krasnyy Proletariy Plant has designed a welded bed for the model 16 K20 lathe on the basis of sheet metal in lieu of gray cast iron. Comparison tests of strength, vibration resistance, and resistance to strain demonstrated the superiority of the welded design. The net weight of the welded bed was 580 kg compared with 1400 kg for the cast bed. However, the plant has neither the facilities--it consists chiefly of machine-assembling shops--nor the space for the production of such lathe beds, and it cannot find a supplier plant for this purpose. Similar projects for replacing cast components with their welded counterparts have been developed by other organizations. For example, the Agricultural Machinery Plant imeni Ukhtomskiy several years ago developed a new design of the KS-2.1 mounted high-speed mowing implement, weighing 70 kg less than the currently manufactured type. In the new mowing implement many components are of rolled stock instead of castings, and it is based on lighter billets, but so far it still exists only in the design stage.

The problem of the technological readiness of the machine building industry for utilizing the growing output of quality types of metal products has yet to be tackled. Machine building is ready to use those rolled sections which require no further processing and no special-purpose equipment, particularly curved sections, helically rolled sections, special-purpose sections, and high-precision sections. On the other hand, an expanded use of sheet metal by machine building requires appropriate cutting, forging, and welding equipment. The greatest difficulties are encountered in the introduction of high-strength steels. The handling of such materials requires extra-hard dies and tools or the employment of new technologies such as electro-physical, electrochemical, and laser technologies.

Progressive types of rolled stock, which are closer in shape and dimensions to manufactured product parts, require less equipment, and in particular fewer metal-cutting machine tools--which at present account for the principal part of technological equipment in machine building plants. However, it will become necessary to increase the output of other types of equipment, e.g., cold-forging, electric welding, and other equipment.

* * *

The acceleration of the pace of introduction of progressive equipment and technologies, as well as the efficient utilization of metals, is influenced tremendously by the methods of organizing the production and consumption of economical types of metal. Analysis of the technical and organizational level of the production of economical types of metals serves to isolate certain directions of the optimization of the organizational structure of metallurgical production: intensive development of the rolling and finishing

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030055-6

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operations and of the oxygen-converter, electric melting, and other progressive methods; organization of the construction of mini-plants; conversion from the production of foundry cast iron in ferrous metallurgy to specialized casting in machine building; and the development of reserve production capacities in ferrous metallurgy.

A factor in intensifying the development of ferrous metallurgy has been the increase in the share of capital outlays on rolling and finishing operations. According to the TsNIIchermet, the capital outlays on the priority development of rolling and subsequent finishing operations are roughly one-half as high as the expenditures on the creation of new capacities for the entire metallurgical cycle "from ore to metal." The savings accruing to the national economy (in terms of adjusted expenditures) by the improvements in the quality and broadening of the structure of metal products amounted to 500 million rubles in 1966-1970 and 300 million rubles during 1971-1975, while during 1976-1980 they will have reached 700 million rubles. The savings of rolled stock in machine building and metalworking amounted to 4.4 million tons during the Eighth Five-Year Plan period and 6.3 million tons during the Ninth. During the Tenth Five-Year Plan period these savings are expected to reach 7 million tons. The share of the savings of rolled stock due to the use of high-grade steel is increasing: during 1971-1975 it accounted for 33.2 percent of all savings of metal compared with 15.2 percent during 1966-1970.

In recent years, the share of capital outlays on rolling and, particularly, finishing shops has been rising. During the Ninth Five-Year Plan period the capital outlays allocated on improving the quality of rolled stock increased by a factor of 1.7 compared with an overall 1.35-fold increase in all capital outlays. As a result, the share of the outlays spent on improving the quality of rolled stock and on finishing shops reached 19 percent during the Ninth Five-Year Plan compared with 17.3 percent during the Eighth. At the same time, however, it should be pointed out that during that period the capital outlays allocated to ferrous metallurgy were underutilized (by roughly 20 percent), and of these the outlays on improving the quality of metal were cut in half. This has adversely affected the overall savings of metal in the national economy, both in kind and in monetary terms. Thus, the savings of metal turned out to be nearly 2 million tons smaller than planned. The plan targets as to the improvements in quality and expansion of structure of rolled stock were underfulfilled. The causes of this situation include: underfulfillment of the plan for the activation of production capacities within the branch, incomplete deliveries of the needed equipment, and slow completion of new projects.

During the Tenth Five-Year Plan period the capital investments allotted for the rolling and finishing shops and for improving the quality of metal production will have been more than doubled, whereas for ferrour metallurgy as a whole they will have been increased by a factor of 1.4. The increase in capital outlays on rolling and finishing operations essentially signifies

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a qualitative step forward in the development of ferrous metallurgy and reflects the growth of intensive methods of management.

The achievements of science and technology in the production of metals warrant re-examining the attitude toward the concentration and specialization of production in ferrous metallurgy. It has now become possible to organize not only large combines but also the so-called mini-plants whose construction and operation are cost-effective. The most up-to-date technology used in such cases, which makes it possible to operate small high-productivity facilities and to convert at a low cost from one type of rolled stock to another, is based on principles of continuity, which assures stability of the quality of metal and a marked increase in productivity. Consequently, the mini-plants can produce a broader variety of products in small batches than can large combines with giant high unit capacity facilities.

The continuity of technological processes will make it possible in the future to accomplish complete and highly effective mechanization and automation of production. Such enterprises can in addition generate electric power and produce building materials, which will serve to sharply reduce capital outlays, shorten the construction cost, and accelerate the recoupment of expenditures. The capital investments per ton of steel in the construction of mini-plants are one-fifth as high as in the construction of large plants, and their construction periods are one-fourth as long. Labor productivity per worker is 2-5 times as high? Moreover, less production space is needed and the pollution of water and air basins is averted.

The production of foundry cast iron in ferrous metallurgy causes shortfalls delaying the production of conversion cast iron by 3 million tons and hence also the production of rolled stock by 3.5 million tons. The quality of cupola-furnace castings is inferior and the expenditures on coke and coal in the production of foundry cast iron are higher, compared with the production of conversion cast iron. Moreover, the productivity of blast furnaces is some 26 percnet lower, and the losses due to burnout are substantial. For these reasons, the production of foundry cast iron should be transferred to specialized machine-building foundries equipped with induction furnaces. The smelting of iron in such furnaces assures a high quality of castings, whose strength is then enhanced by a factor of 1.5-2, and moreover it is then possible to produce thin-walled castings and reduce their weight by 15-20 percent. All this contributes to reducing the weight of machinery and improving their reliability and service life.[3]

In view of the rapid pace of scientific and technical progress, it should be noted that the availability of a definite production capacity margin is a prerequisite for the rapid organization of new types of production and prompt satisfaction of the demand of the user branches. In ferrous metallurgy the actual capacity utilization is high--95-98 percent. As a result, an enterprise is sometimes short of production capacities for even achieving its planned output target. The causes of such a situation are, in

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our opinion, attributable to the practice of planning metal output in tons of the attained level, the inadequate allocation of capital investments on capacity expansion, and the slow utilization of capital investments and completion of new projects. The establishment of a production capacity margin should be optimal, on taking into account the developmental prospects of the progressive types of production.

Of major importance to an intensive introduction of progressive equipment and technology of metalworking and metal savings is improving the organizational structure of the preparatory processes in machine building, that is, raising the level of the concentration and specialization in the production of particular types of components. At present nearly every machine building enterprise maintains its own small preparatory shops or sectors for the production of castings, die forgings, and welded metal structures. The technical level of these shops is, as a rule, insufficiently high while the variety of products they make is broad, and this results in a low metal utilization factor as well as in production costs that are 1.5-2 times as high as in specialized production shops. The level of technological specialization in machine building is not high. Even in one of its most specialized branches--in tractor and agricultural machine building--it is aobut 1.6 percent. The centralized production of castings, die forgings, and welded metal structures accounts for only about 3 percent of their production in machine building. At the same time, the insufficiently high degree of the specialization and concentration of preparatory production in machine building impedes the introduction of high-productivity equipment and effective technological processes, which adversely affects the efficiency of metal utilization, productivity of labor, and production cost.

* * *

The elevation of the technological and organizational level of the branch with the object of saving metal hinges on the indicators envisaged in the planning and stimulation of production. The practice of planning, evaluating, and providing incentives for output in terms of tonnage results in emphasis on the production of heavy and metal-consuming rolled stock. Moreover, such practice impedes the organization and production of new and more economical rolled sections and pipe, in particular, the thin-walled kind, since then the technical-economic indicators of an enterprise's performance deteriorate: the volume of marketed output and labor productivity decreases and the labor and capital requirements of production increase. All this adversely affects the incentive funds and causes the enterprises to lose interest in producing lightweight types of rolled stock.

The ferrous metallurgy, as in other branches of industry, a great deal of work is under way to improve the planning of production and the assessment of the performance of enterprises as well as of economic stimulation. This work is intended to improve the planning of metal, billets, and certain types of equipment (in tons) with allowance for the quality and metal requirement of production, and to improve the assessment of the economic

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performance of enterprises (in terms of volume of marketed output). In this connection, it is important to utilize more fully the system of surcharges and rebates on wholesale prices as tailored to the metal requirement and quality of output.

The Decree of the CPSU Central Committee and the USSR Council of Ministers "On Improving the Planning and Intensifying the Effect of the Economic Mechanism on Increasing the Effectiveness of Production and Quality of Performance" provides for strengthening the role of prices in the expansion of the output of high-quality products. To this end, it broadens the scope of wholesale-price surcharges applied to new highly effective products whose parameters correspond to the best domestic and foreign specimens, and it strengthens the sanctions applied to the fabrication of outdated products. The sum total of the surcharges and rebates is not taken into account in the plans, but the fulfillment of the plans is evaluated on taking them into account. It is expedient to plan certain types of rolled stock in meters or square meters, and to plan equipment in nomenclatural terms with allowance for technical and economic parameters. It is more progressive to assess the performance of enterprises and branches in terms of the index of net output, which causes enterprises to lose interest in increasing the output of the more material-consuming product types and provides the premises for reducing the material requirements of production. The Decree has introduced the index of net (normative) output for the planning and assessment of the productive and economic performance of industrial ministries, associations, and enterprises.

At present the streamlining of the structure of metal consumption is impeded not only by the insufficient volume of output of quality types of metal. The users, i.e., those in machine building, operate under conditions which impede the introduction of more economical types of rolled stock and the efficient utilization of metal. This concerns the technological and organizational levels of preparatory production and design work in machine building as well as the system for planning and stimulation of metal consumption.

The shortage of ferrous rolled stock and the limits imposed on its distribution lead to the condition that any batch of metal products can find a user so long as it satisfies minimal standards or technical conditions. Thus, the manufacturer lacks the incentive for producing output of higher quality. Once the decisions adopted in the aforementioned Decree are implemented, the possibilities of the user branches will be broadened and mutual responsibility will be increased. The Decree provides for assessing the economic results of the performance of industrial enterprises, and for an incentive system based chiefly on the fulfillment of output delivery plans according to product lists and contractual schedules. Sanctions for violations of output delivery contracts are imposed.

The production of certain types of equipment, structural elements, castings, and die forgings is planned in tons, but the economic performance of the

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enterprises is assessed in terms of the volume of marketed output. Hence the user branches (associations and enterprises) lack the incentive for using lightweight rolled stock and billets. The replacement of castings with die-forged and welded sheet-metal components is proceeding slowly owing to the shortage of the needed rolled stock, insufficient production of forging and welding equipment, and lack of interest in such replacement on the part of the enterprises. As regards hot-rolled stock, the standards for its consumption are governed by centralized planning, and each year they are reduced, but there is no rigorous planning and economic targeting as regards castings. As a result, the volume of output of castings is unjustifiably rising and the share of castings in the structure of metal output as a whole is decreasing too slowly, thus impeding a reduction in the weight of machinery. A number of machine-building enterprises tend to increase the share of castings in the construction of individual machine types, particularly the enterprises operating their own foundry shops. To fulfill the plan for saving rolled stock, plants convert to using parts made from castings rather than from rolled stock.

In our opinion, it is expedient to plan for savings of not only hot-rolled stock but of all metal, as well as to plan in terms of the absolute and relative weight of all products and the coefficient of metal utilization, and to stimulate these directions of increasing the effectiveness of production. It is also important to strengthen the role of the index of absolute and relative metal requirement (material requirement) in the certification of products. In our view, metal structural elements should not be certified and perhaps should not even be produced if they are heavier than their counterparts manufactured in other countries.

The machine-building enterprises at present employ the standard "Limiting Products List of Rolled Metal Stock," which is based on the sizes of rolled stock and grades of steel used in the machines built by an enterprise. This standard is intended to simplify the design and reduce the production time of the types of metal used in the necessary quantities, as well as to limit the nomenclature of the metal received. It is also designed to select the metals needed when developing new machinery and modernizing currently built machinery. The types of rolled stock that are not listed in that standard or that have been newly developed in ferrous metallurgy can be used in every individual case only upon permission of the plant's chief engineer. In our opinion, such a standard impedes the introduction of economical types of metal and results in an increase in the weight of the machines built; that is, it retards technical progress.

The development and introduction of machinery and equipment often are delayed by factors that are not the fault of the designer or even of the enterprise. The newly used types of rolled stock and equipment have to be funded, which entails considerable difficulties. Suppliers of materials, components, or prefabricated assemblies are needed, and this complicates interbranch connections. The number of machines built must be markedly

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increased to warrant reducing their cost (owing to the reduction of their weight) so as to fulfill the plan for the volume of marketed output, since planning is based on the previously achieved level. As a result, the introduction of progressive lightweight designs in industry can take years. The accelerated organization of new highly economical production will be assisted by the implementation of the new Decree of the CPSU Central Committee and USSR Council of Ministers on Improving the Planning and Economic Mechanism, which provides for an entire system of measures to further improve the planned management and stimulation of the development of the socialist economy.

Thus, the maximal satisfaction of the demand of the national economy for metal products satisfying in quality and variety the requirements of technical progress and contributing to an increase in effectiveness requires an intensification of the processes of the production and consumption of ferrous metals. It is expedient to accelerate the production of the already developed types of equipment and to develop new metallurgical facilities capable of assuring a radical improvement in the quality and variety of rolled stock and savings in the consumption of metal. The structure of the pool of metalworking equipment should be streamlined through a more rapid development of the production of progressive equipment for precision methods of casting, welding and pressure working, and for the rolling of precision billets.

The acceleration of the technological re-equipping of the processes of the production and consumption of metal will be assisted by the optimization of the organizational structure of ferrous metallurgy, and particularly by increasing the proportion of rolling and finishing operations and the specialization of preparatory operations in machine building. The stimulation of the production and consumption of economical types of metal should be based on improvements in the system for planning the production, distribution, and consumption of ferrous metals, as well as in the assessment of the economic performance of industrial enterprises.

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1. See D.I. Popov, "Povysheniye Effektivnosti Proizvodstva i Kachestva Produktsiy--Glavnaya Zadacha Chernoy Metallurgii" [Increasing the Effectiveness and Quality of Production as the Main Task of Ferrous Metallurgy]. Izd-vo Metallurgiya, 1977, p 6.

2. See EKO, No 4, 197, p 87.

3. Induction furnaces are effectively operating at a number of the nation's machine building enterprises. However, the share of induction melting in the total volume of foundry cast iron is still low, being 5.3 percent compared with 40 percent in Japan, 30 in the United States, and 37 in Federal Republic of Germany.

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REFRACTORY MATERIALS

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REFRACTORIES FOR NEW METALLURGICAL PROCESSES

Moscow OGNEUPORY in Russian No 3 1979 pp 1-4

[Article: "Refractories for New Metallurgical Processes"]

[Text] Implementing the resolutions of the 25th CPSU Congress, this country's metallurgical workers are successfully adopting advanced production methods and methods of improving metal quality: steelmaking in oxygen converters, electric furnaces, vacuum, electroslag, plasma, and electron-beam remelting, continuous casting, treatment of molten steel with synthetic slags and inert gases, and out-of-furnace degassing. Utilization of oxygen and natural gas in metallurgical production is expanding. Economical methods of enrichment and nodulizing of oxidized iron ores are being adopted. There are plans to adopt on a commercial scale the process of obtaining iron from ore by the direct reduction method.

Metallurgical workers, carrying out technological retooling of this branch of industry, modernizing existing and putting on-stream new and high-output metallurgical installations, are honoring their holiday with labor victories.

A successful job of adopting new processes by our metallurgical workers depends to a great degree on providing the metallurgical industry with efficient, high-quality refractories.

Refractory industry workers regularly meet the targets pertaining to development of new and expansion of production of efficient types of refractory products and high-quality materials for advanced industrial processes in ferrous metallurgy and other branches of the economy.

Refractories have been developed, put into production and are being delivered in filling orders for large-volume blast furnaces and blast stoves with a blast temperature of up to 1400°C. Kaolin products with an open porosity of not less than 12% are being supplied for blast furnaces, water-free taphole material ensuring reliable closing and high stability of iron notches, and for high-temperature blast stoves -- perforated checkerwork blocks and wall materials of kaolin, mullite, mullite-corundum and fireclay compositions and of low-friability silica, and for equipment thermal insulation -- lightweight silica products and insulating mats of kaolin fiber.

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Each year there is an increase in steelmaking in oxygen converters of 300 tons capacity and larger, in which resin-magnesite and resin-dolomite-magnesite unkilned refractories are employed. Piece items employed to close converter tapholes have been replaced with blocks of fused magnesite, which has made it possible to double the durability of taphole lining.

Metallurgical workers and workers in the refractories industry have the task of achieving a sharp increase in the durability of converter linings. The All-Union Refractories Institute, jointly with the Donetsk Scientific Research Institute of Ferrous Metallurgy, has developed and incorporated at the Western Siberian Metallurgical Plant a technique of flame-guniting oxygen converter lining, which has made it possible to double lining durability. This method is being extensively adopted at Soviet and foreign metallurgical enterprises.

Refractories based on fused magnesite, chromite and electrocorundum have been developed and are extensively employed in steelmaking. These refractories are used for linings of individual elements of large oxygen converters, crowns and walls of electric steelmaking furnaces with powerful transformers, out-of-furnace steel degassing, plasma and electron-beam remelting equipment, as well as induction furnace crucibles.

Each year there is an increase in the quantity of continuous-cast steel, an annual increase of approximately 15 million tons. Curved-type continuous casting machines at the Novolipetskiy Metallurgical Plant and the Azovstal' Plant are receiving an uninterrupted supply of steel-casting nozzles of quartz glass manufactured at the Podol'sk Refractory Products Plant. Corundum-graphite nozzles manufactured at the Novomoskovsk and Bogdanovich refractories plants, zirconium nozzles at the Krasnoarmeysk Silica Refractories Plant, and zirconium-graphite nozzles at the Borovichi Refractories Combine are also being supplied for the intermediate ladles of continuous casting machines. Production is starting up on refractory tubes to shield the stream of metal from oxidation.

Refractories enterprises are providing metallurgical workers with a continuous supply of heat-insulation inserts, which are being utilized more and more extensively in pouring killed carbon steel into ingot molds. By insulating the ingot top with inserts, ingot trimming is reduced by approximately 14%. Approximately 15 million tons of steel is being cast in ingot molds with insulating inserts.

Periclase and corundum porous plugs and blocks for bottom blasting and tuyeres for top blasting and adding lime are being supplied for treating molten steel with inert gases. Refractories are being produced for electroslag steel pouring, bulk and powdered periclase and quartzite for packing induction furnace crucibles. Steel pouring with employment of sliding gates is becoming quite widespread. In 1978, 39 million tons of steel were poured with this advanced technique, while by the end of 1979 the figure is to climb to 80 million tons.

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Enterprises of the refractories industry are expanding production of sectional plates for steel pouring ladle gates (Vnukovo Refractory Products Plant, Magnezit Combine) and corundum-mullite plates (Semiluki Refractories Plant); biceramic plates and plates of mullite-corundum and zirconium composition are also being produced (Chasov-Yar Refractory Products Plant, Krasnogorovka Refractories Plant, Nikitovskiy Dolomite and other plants).

Fourteen metallurgical enterprise shops, including six converter shops, six open-hearth shops, and two electric steelmaking shops, have converted over entirely to stopperless steel pouring.

Metallurgical enterprises are successfully adopting continuous lining in steel pouring ladles in place of brickwork. Approximately 12% of all steel-teeming ladles have been converted over to continuous packed and poured-on linings of bulk quartz-clay and silica. This has made it possible to save more than 115,000 tons of ladle material and to reduce severalfold labor requirements in lining steel-teeming ladles. In 1978 approximately 16 million tons of steel were poured from ladles with monolithic linings.

Adoption of semi-dry guniting of steel-teeming ladle lining doubled lining durability. In 1978 more than 16.2 million tons of steel were poured with the employment of gunited ladles. Guniting of steel-teeming ladles is to increase substantially in 1980.

The Bogdanovich Refractories Plant and the Ukrainian Refractories Institute have developed and incorporated a process of manufacturing kaolin fiber and felt produced from it. The manufacture of kaolin fiber, slabs and mats has increased.

Metallurgists are successfully employing heat-insulating refractories of kaolin fiber, which represent a highly-efficient material the value of which is very great for construction of heat equipment. Employment of these refractories reduces by 40-60% the consumption of raw materials for production and substantially reduces the amount of brickwork and fuel consumption.

A process has been developed for the manufacture of heat-insulating lining inserts based on kaolin fiber. Employment of these inserts in ingot molds during steel pouring has promoted an increase in yield of usable metal. Concretes with the addition of kaolin fiber have been developed and adopted for lining roasting equipment at mining and ore beneficiation combines.

Work has continued on the development and adoption of special refractories for mass production of high-quality metal in steelmaking shops with equipment of high unit capacity.

Productive cooperation between metallurgical and refractory workers in putting on-stream the first unit of the oxygen converter shop at the Zhdanov Metallurgical Plant, Azovstal' imeni Sergo Ordzhonikidze, made it possible to supply the shop with refractories in a prompt and timely manner.

Some refractories for high-temperature processes, however, are being produced in limited quantity and are failing to meet the needs of the

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economy. With the objective of increasing the production of highly-efficient refractories, plans call for expanding the raw materials base of the refractories industry, beneficiation of refractory raw materials, improvement of existing and development of new industrial processes, and manufacture of the means of mechanizing refractories production.

Special attention is being focused on adoption of technology and obtaining concentrated magnesite with a 95.5 and 99% MgO content, concentrated kaolin and fireclays.

The Magnezit Combine, the Vnukovo Refractory Products Plant, the Panteleymonovka and Kondrat'yevskiy Refractories plants are expanding capacity to produce plates for sliding gates, which will make it possible substantially to increase steel pouring through these gates.

Facilities are being built and enlarged for the production of graphite-containing refractories at the Konstantinovka Refractories Plant, zirconium nozzles and plates for sliding gates at the Krasnoarmeysk Silica Refractories Plant, products of zirconium dioxide concentrate at the Borovichi Refractories Combine, products of fused quartz at the Velikoanadol'skiy Fireclay Plant, electrofused (corundum, mullite, quartz) refractories at the Kazogneupor Plant, fused-cast periclase and magnesite-chromite refractories at the Magnezit Combine, fiber heat insulating materials at the Bogdanovich, East Siberian Refractories and Seversk Dolomite plants.

Plans call for expanding production of powders and mixtures for refractory concrete, bulk packing materials and gunite by putting new production facilities on-stream at the Magnitogorsk Metallurgical Combine, the Borovichi Refractories Combine, the Kazogneupor Plant (high-alumina bulk materials), the Nizhniy Tagil Metallurgical Plant (dunite and periclase-spinellide bulk materials), the Magnezit Combine (magnesial gunite bulk materials, components of refractory concretes, oil-treated magnesite powders), the Pervoural'sk Silica Refractories Plant (quartzite bulk materials), the Bogdanovich Refractories Plant (concrete blocks, gunite bulk materials and powders), the East Siberian Refractories Plant (quartz-clay bulk materials), the Nikitovskiy Dolomite Plant (magnesial gunite bulk materials), and the Ovruch Ore Administration (quartzite bulk packing materials).

A plant is being built to manufacture mechanization equipment for the enterprises of Soyuzogneupor, as well as a shop at the Chasov Yar Experimental Plant for the manufacture and repair of bottom plates. Machines for removing clay bricks from presses and loading them onto cars are being developed and put into production, as are units for taking down batches of kilned products, and equipment for film-packaging products and packaging plastic refractories in polyethylene bags.

Refractories institutes are conducting scientific research in the area of improving product quality, development of new refractories, and boosting the level of production mechanization. Plans call for expanding the experimental-industrial base of refractories institutes.

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The efforts of all teams of workers, engineers, technicians and scientists in the refractories industry should be focused on achieving the designated targets, in order to provide adequate quantities of high-durability refractories to the metallurgical industry and other branches of the economy.

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